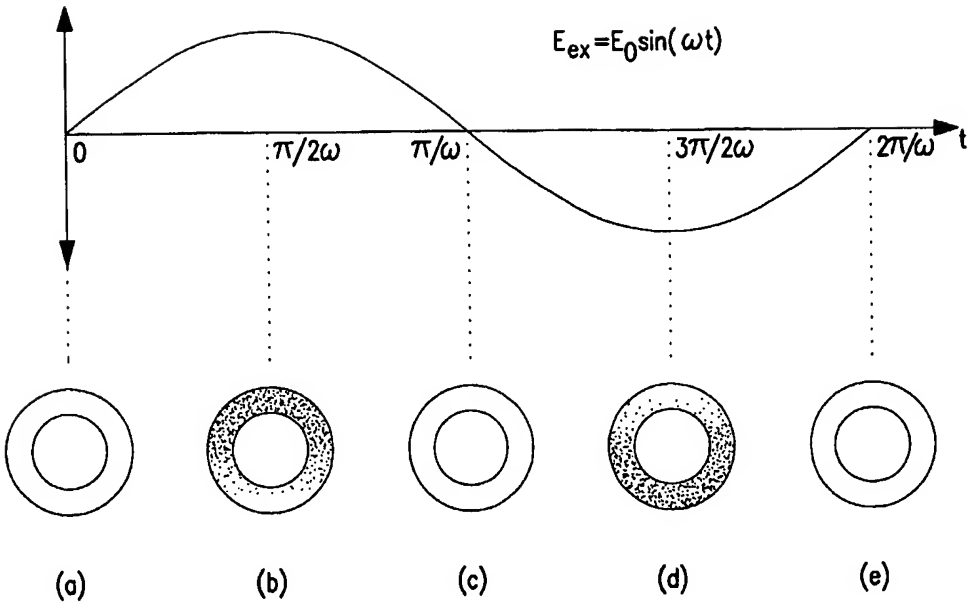

$E_{ex}=E_0\sin(\omega t)$
0
$\pi/2\omega$
π/ω
$3\pi/2\omega$
$2\pi/\omega$
t
(a)
(b)
(c)
(d)
(e)

FIG. 1

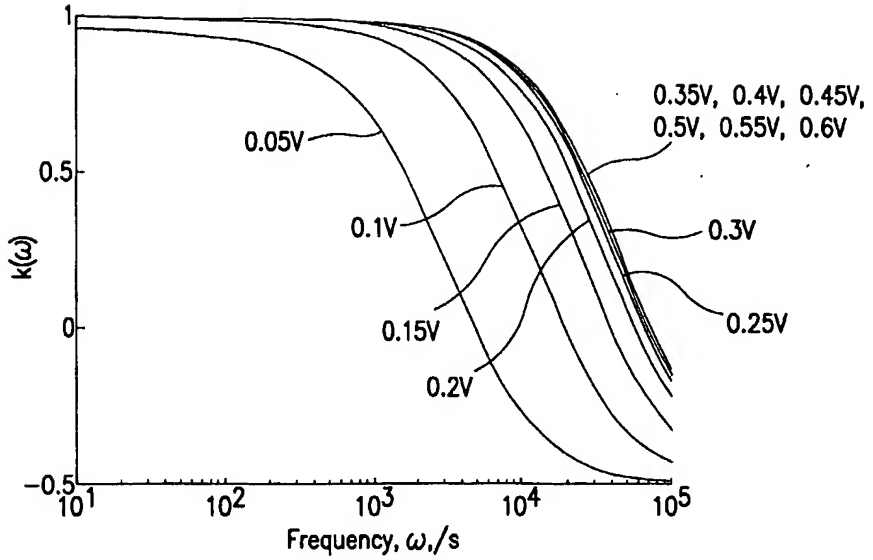

1
0.5
0
−0.5
k(ω)
0.05V
0.1V
0.15V
0.2V
0.35V, 0.4V, 0.45V,
0.5V, 0.55V, 0.6V
0.3V
0.25V
10^1
10^2
10^3
10^4
10^5
Frequency, ω,/s

FIG. 2

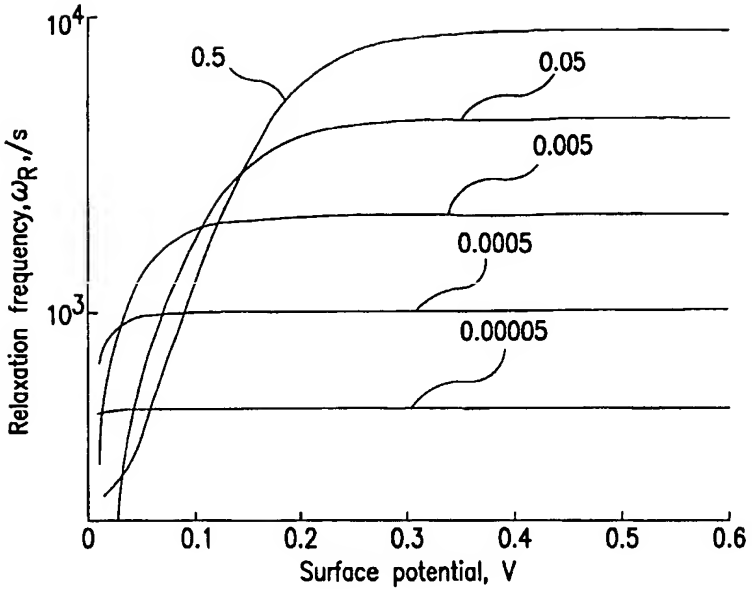

10^4
10^3
0.5
0.05
0.005
0.0005
0.00005
Relaxation frequency, ω_R, /s
0
0.1
0.2
0.3
0.4
0.5
0.6
Surface potential, V

FIG. 3A

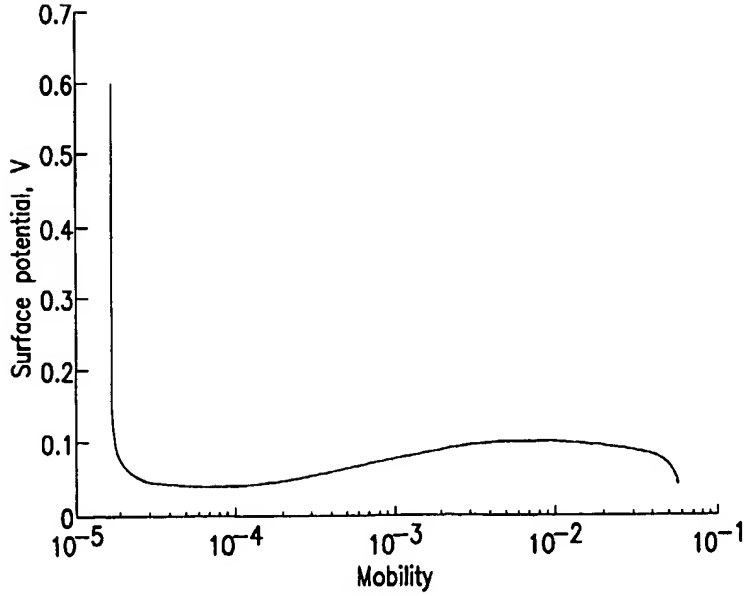

0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Surface potential, V
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
Mobility

FIG. 3B

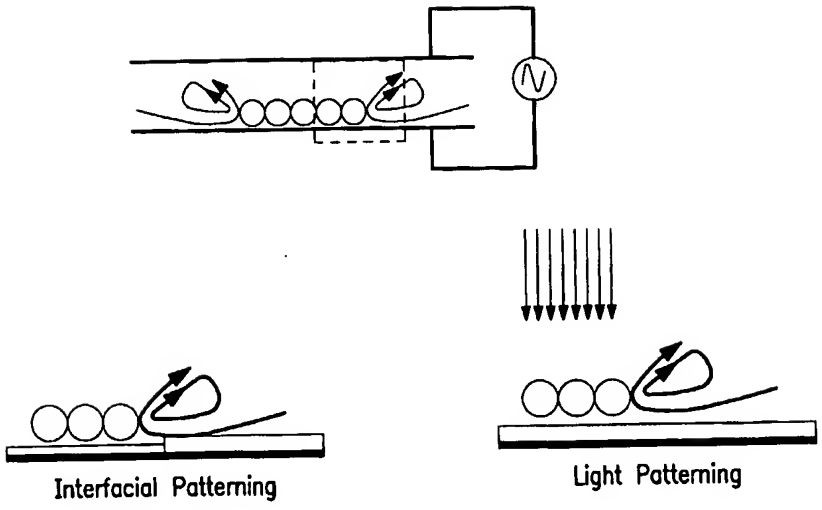


FIG. 4

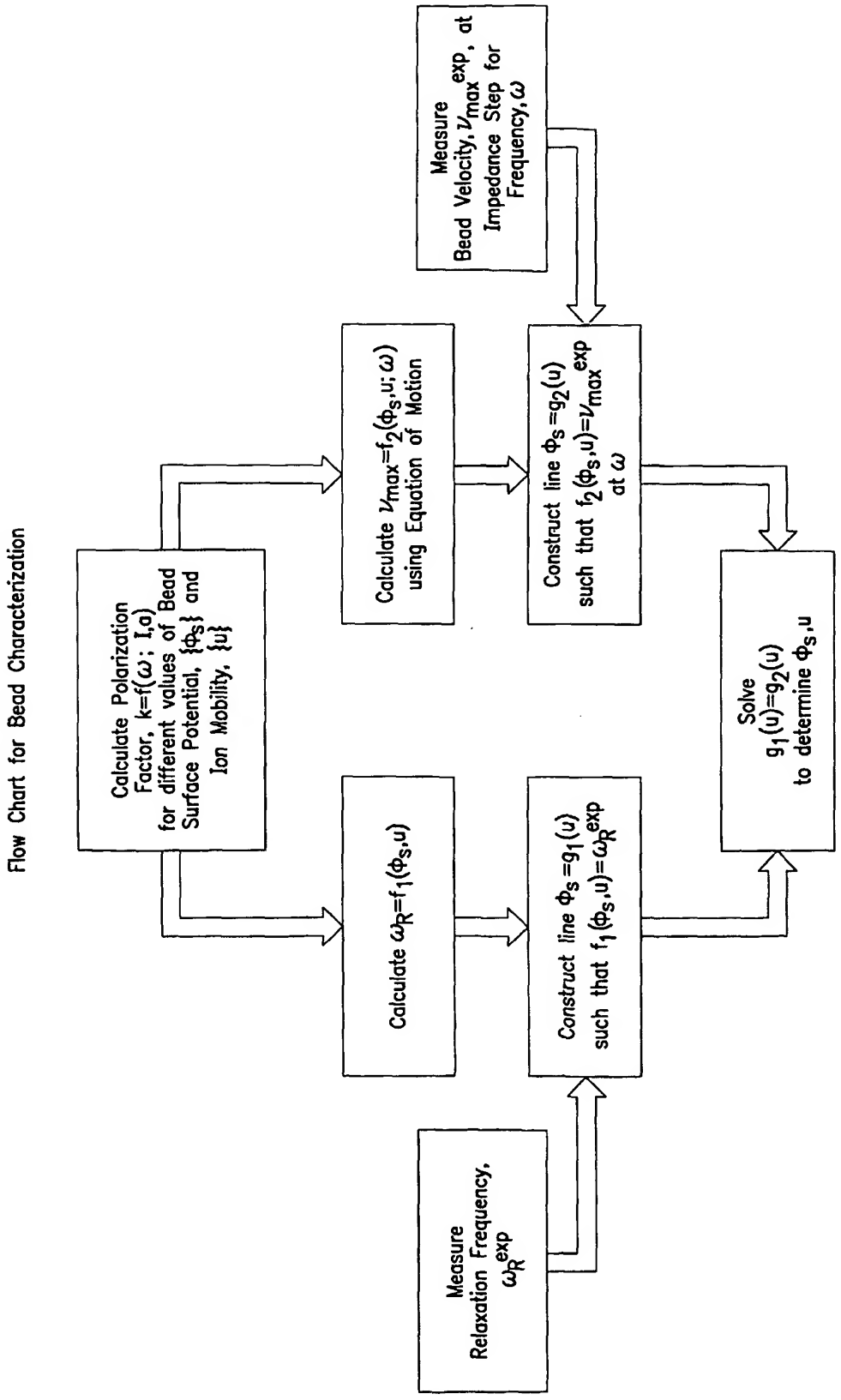

Flow Chart for Bead Characterization
Calculate Polarization Factor, k=f(ω; I,σ) for different values of Bead Surface Potential, {Φs} and Ion Mobility, {u}
Calculate ωR=f1(Φs,u)
Measure Relaxation Frequency, ωR exp
Calculate νmax=f2(Φs,u; ω) using Equation of Motion
Measure Bead Velocity, νmax exp, at Impedance Step for Frequency, ω
Construct line Φs=g1(u) such that f1(Φs,u)=ωR exp
Construct line Φs=g2(u) such that f2(Φs,u)=νmax exp at ω
Solve g1(u)=g2(u) to determine Φs,u

FIG. 5

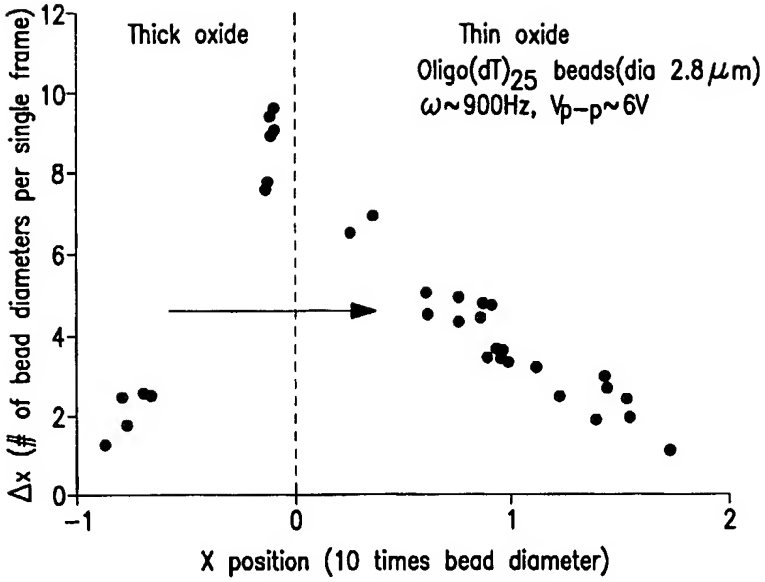

Thick oxide
Thin oxide
Oligo(dT)25 beads(dia 2.8 μm)
ω~900Hz, Vp-p~6V
Δx (# of bead diameters per single frame)
X position (10 times bead diameter)
0
2
4
6
8
10
12
−1
0
1
2

FIG. 6

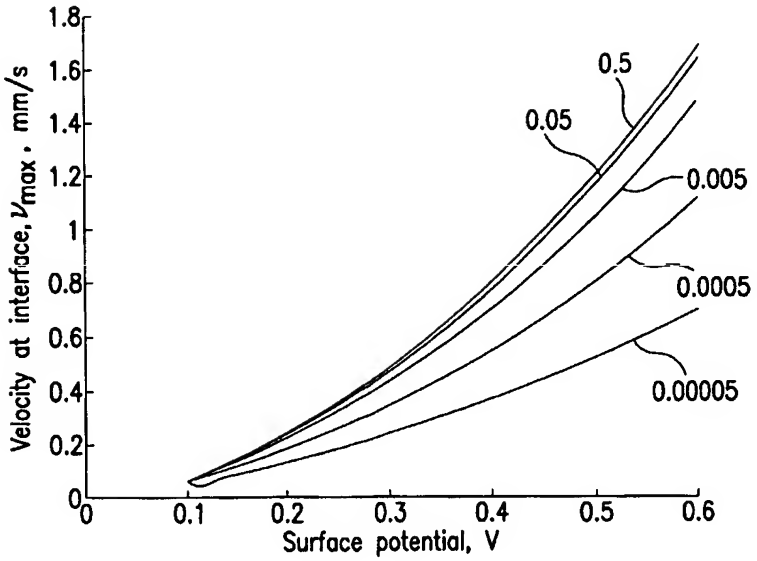

Velocity at interface, v_{max}, mm/s
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.1
0.2
0.3
0.4
0.5
0.6
Surface potential, V
0.5
0.05
0.005
0.0005
0.00005

FIG. 7A

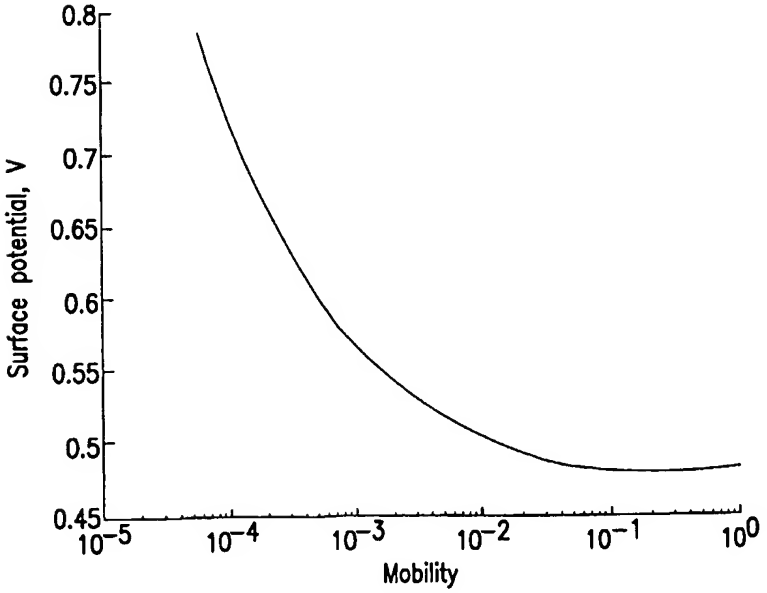

Surface potential, V
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
Mobility

FIG. 7B

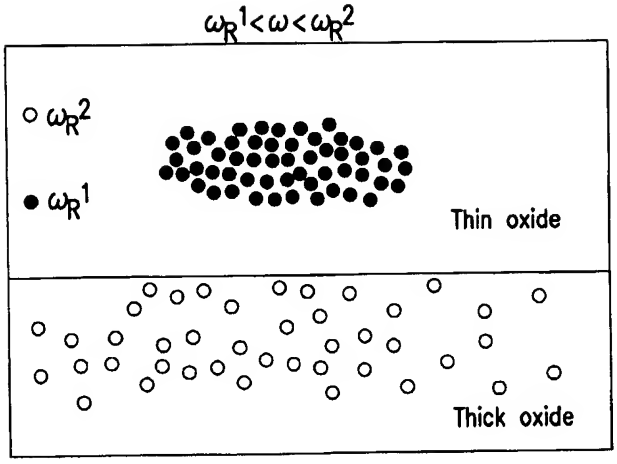
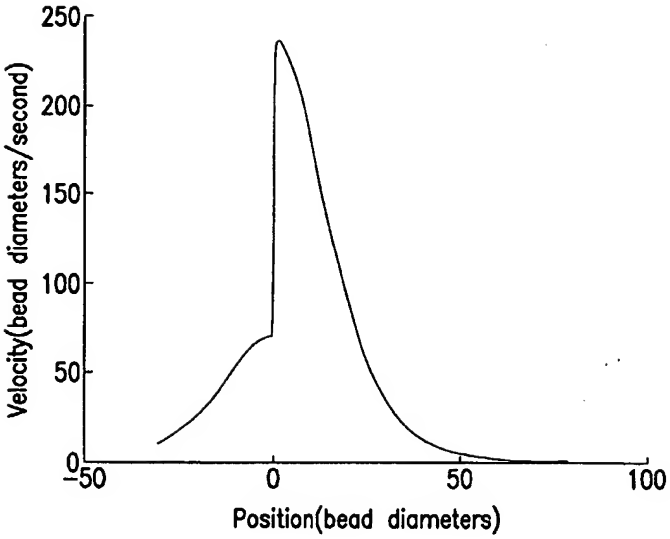

$\omega_R^1 < \omega < \omega_R^2$
ω_R^2
ω_R^1
Thin oxide
Thick oxide

FIG. 8



Simulated bead velocity as a function of position for a bead of diameter 3.2 μm, surface potential 200 mV and ionic strength 0.1 mM, voltage 5 V (peak-to-peak), gap width 150 μm.

FIG. 9

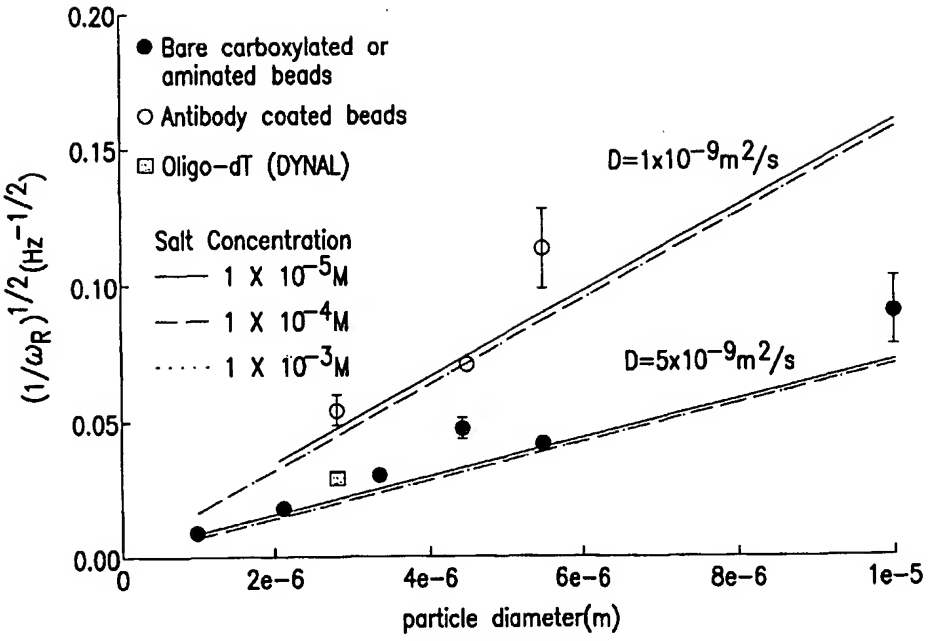

0.20
0.15
0.10
0.05
0.00
0
2e-6
4e-6
6e-6
8e-6
1e-5
particle diameter(m)
$(1/\omega_R)^{1/2}$ $(Hz^{-1/2})$
● Bare carboxylated or aminated beads
○ Antibody coated beads
⊡ Oligo-dT (DYNAL)
Salt Concentration
1 X 10^{-5}M
1 X 10^{-4}M
1 X 10^{-3}M
D=1x10^{-9}m^2/s
D=5x10^{-9}m^2/s

FIG. 10

FIG. 11

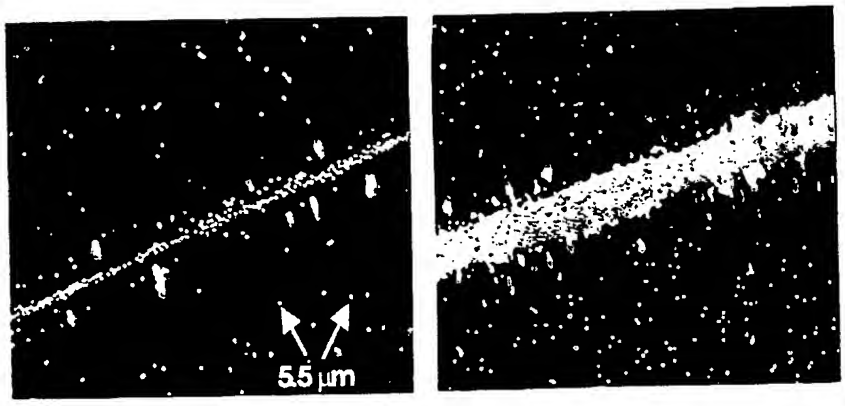


FIG. 12

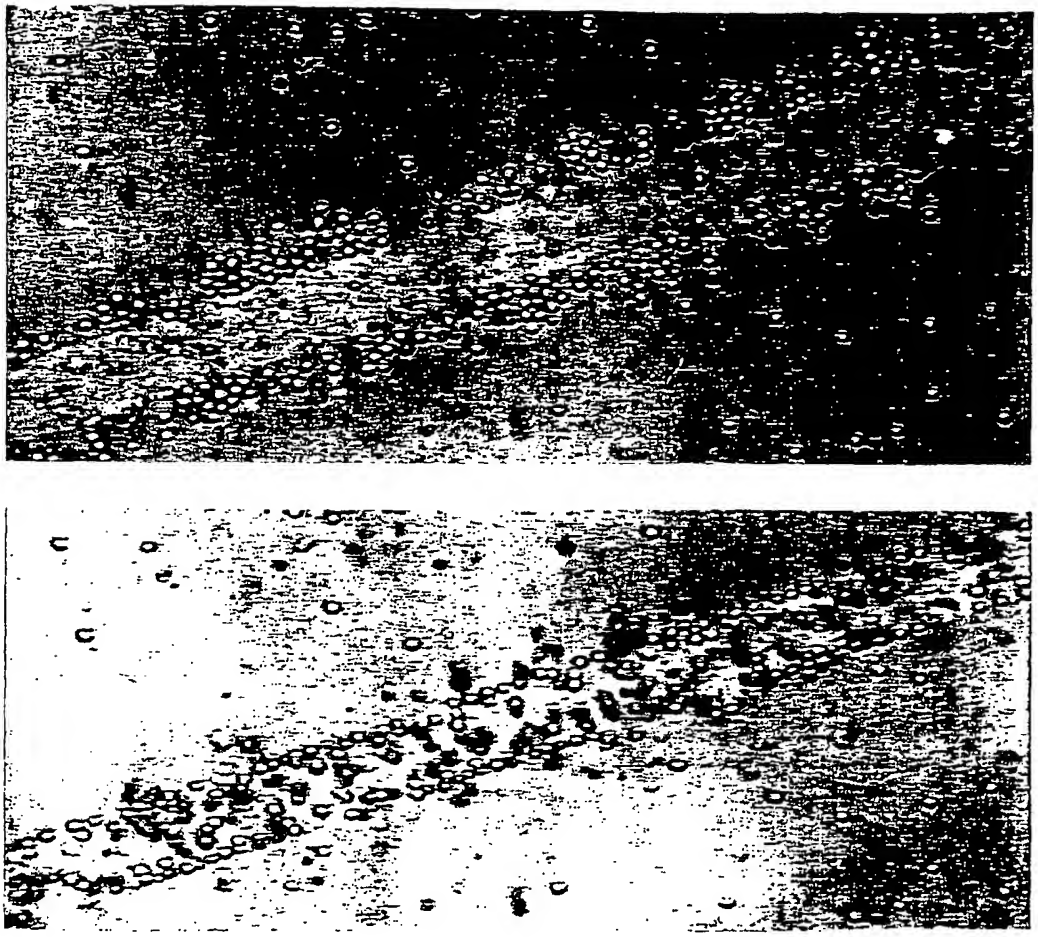


FIG. 13

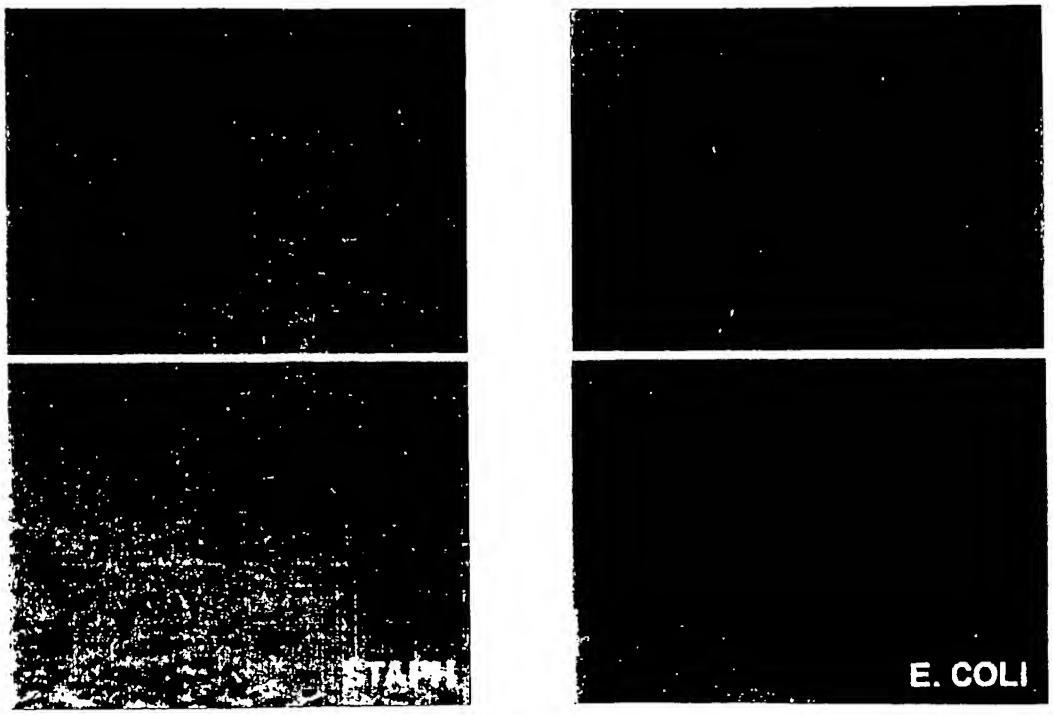


FIG. 14

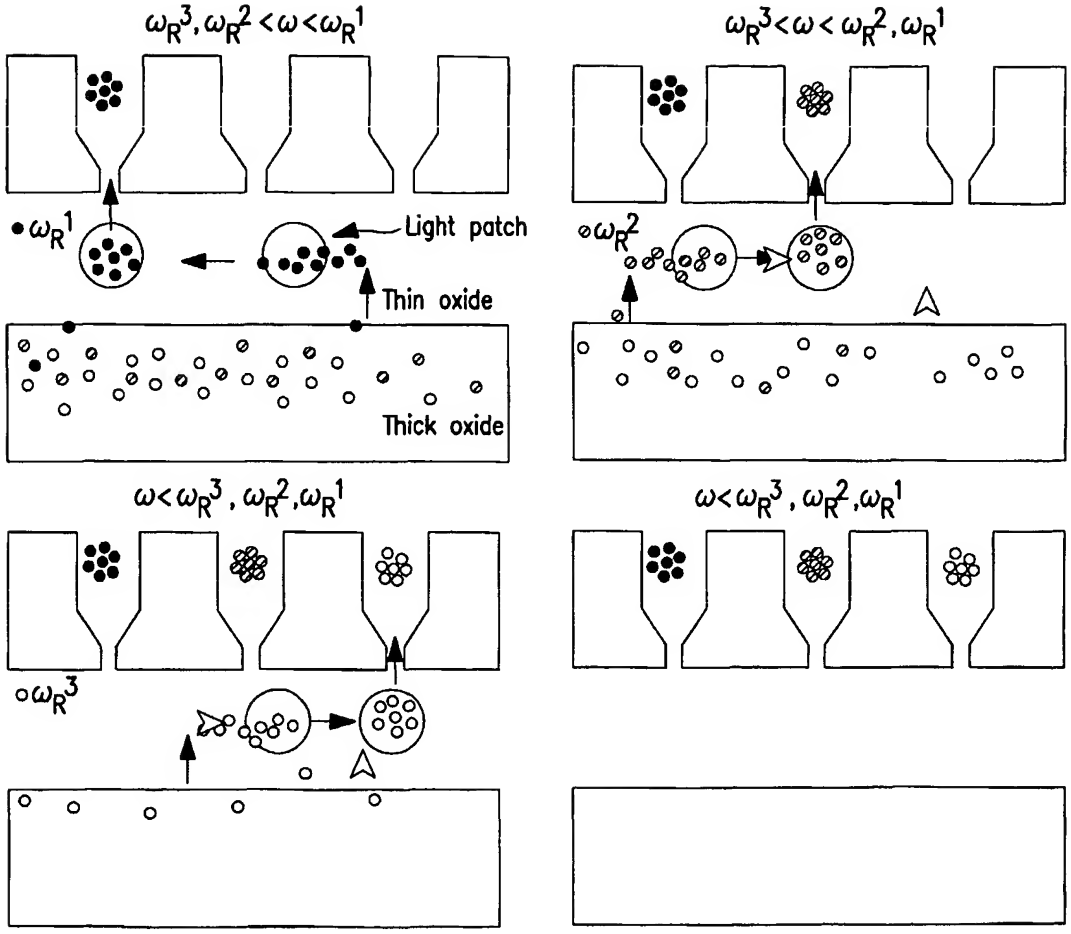

$\omega_R^3, \omega_R^2 < \omega < \omega_R^1$
$\omega_R^3 < \omega < \omega_R^2, \omega_R^1$
ω_R^1
Light patch
Thin oxide
Thick oxide
ω_R^2
$\omega < \omega_R^3, \omega_R^2, \omega_R^1$
$\omega < \omega_R^3, \omega_R^2, \omega_R^1$
ω_R^3

FIG. 15